US011191916B2

(12) **United States Patent**
Bonano et al.

(10) **Patent No.: US 11,191,916 B2**
(45) **Date of Patent: Dec. 7, 2021**

(54) **FILTRATION SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 422 days.

(21) Appl. No.: **15/851,908**

(22) Filed: **Dec. 22, 2017**

(65) **Prior Publication Data**

US 2018/0177962 A1 Jun. 28, 2018

Related U.S. Application Data

(60) Provisional application No. 62/438,040, filed on Dec. 22, 2016.

(51) **Int. Cl.**
A61M 16/00 (2006.01)
A61M 16/10 (2006.01)

(52) **U.S. Cl.**
CPC ***A61M 16/024*** (2017.08); ***A61M 16/0051*** (2013.01); ***A61M 16/106*** (2014.02); ***A61M 16/107*** (2014.02); *A61M 2205/18* (2013.01); *A61M 2205/273* (2013.01); *A61M 2205/50* (2013.01); *A61M 2205/6018* (2013.01); *A61M 2205/6054* (2013.01); *A61M 2205/6072* (2013.01); *A61M 2205/75* (2013.01); *A61M 2205/7545* (2013.01)

(58) **Field of Classification Search**
CPC A61M 16/024; A61M 16/106; A61M 16/107; A61M 16/0051; A61M 2205/18; A61M 2205/273; A61M 2205/50; A61M 2205/6018; A61M 2205/6054; A61M 2205/6072; A61M 2205/75; A61M 2205/7545; A62B 7/00; A62B 7/10; A62B 9/00; A62B 18/00; A62B 18/02; A62B 18/025; A62B 18/04; A62B 18/045; A62B 18/06; A62B 18/08; A62B 23/00; A62B 23/02; A62B 23/025; A62B 23/04; A62B 23/06
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,761,188 B2 7/2010 Palmerton et al.
8,095,241 B2 1/2012 Palmerton et al.
9,492,690 B2 * 11/2016 Hamerly A62B 9/006
(Continued)

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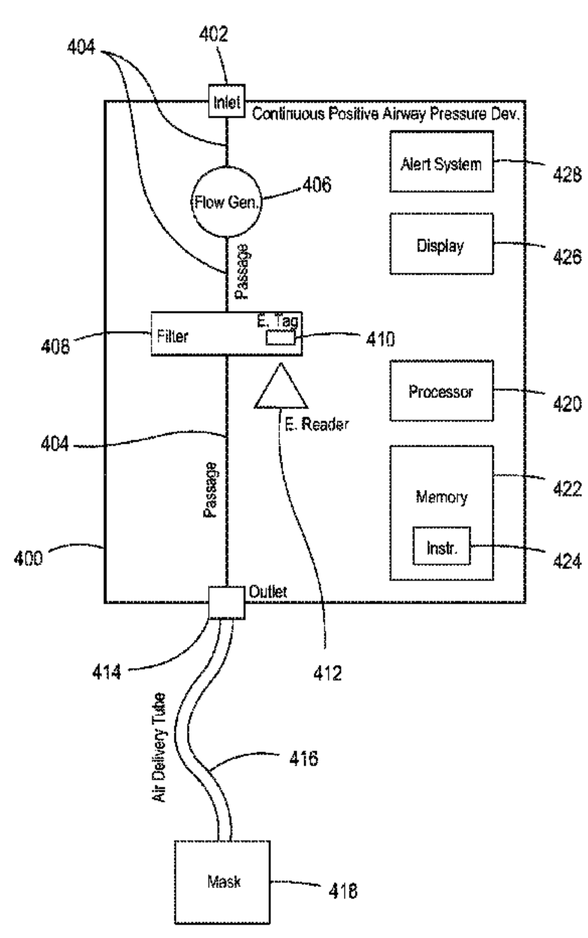
(57) **ABSTRACT**

Presented is a method and apparatus for filtering. An exemplary apparatus includes an air flow generator having a fluid intake fluidly connected to a fluid outlet, and a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter includes an electronic tag operable to transmit identifying information of the removable filter. The apparatus further includes an air delivery tube fluidly connected to the fluid outlet, an air delivery element fluidly connected to the air delivery tube, and a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter.

11 Claims, 4 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0230450	A1*	9/2008	Burbank	A61M 1/1656 210/92
2010/0101575	A1*	4/2010	Fedorko	A62B 7/10 128/204.21
2010/0153023	A1*	6/2010	Parham	A62B 9/006 702/34
2010/0313892	A1*	12/2010	Shigematsu	A62B 18/10 128/207.12
2011/0139154	A1*	6/2011	Henry	A61M 16/00 128/204.21
2013/0239813	A1*	9/2013	Rakow	A62B 9/006 96/108
2013/0327335	A1*	12/2013	Ishikawa	A62B 23/025 128/205.27
2015/0165142	A1*	6/2015	Tham	A61M 16/08 128/202.22
2016/0001102	A1*	1/2016	Huh	A62B 7/10 128/206.17
2016/0046502	A1*	2/2016	Rice	C02F 1/003 210/85
2016/0114281	A1*	4/2016	Bonano	A61M 1/0001 96/131
2016/0151591	A1*	6/2016	Le Bars	A61M 16/024 128/202.22
2016/0317845	A1*	11/2016	Zwolinsky	A61M 16/0875
2017/0368381	A1*	12/2017	Awiszus	A42B 3/225

* cited by examiner

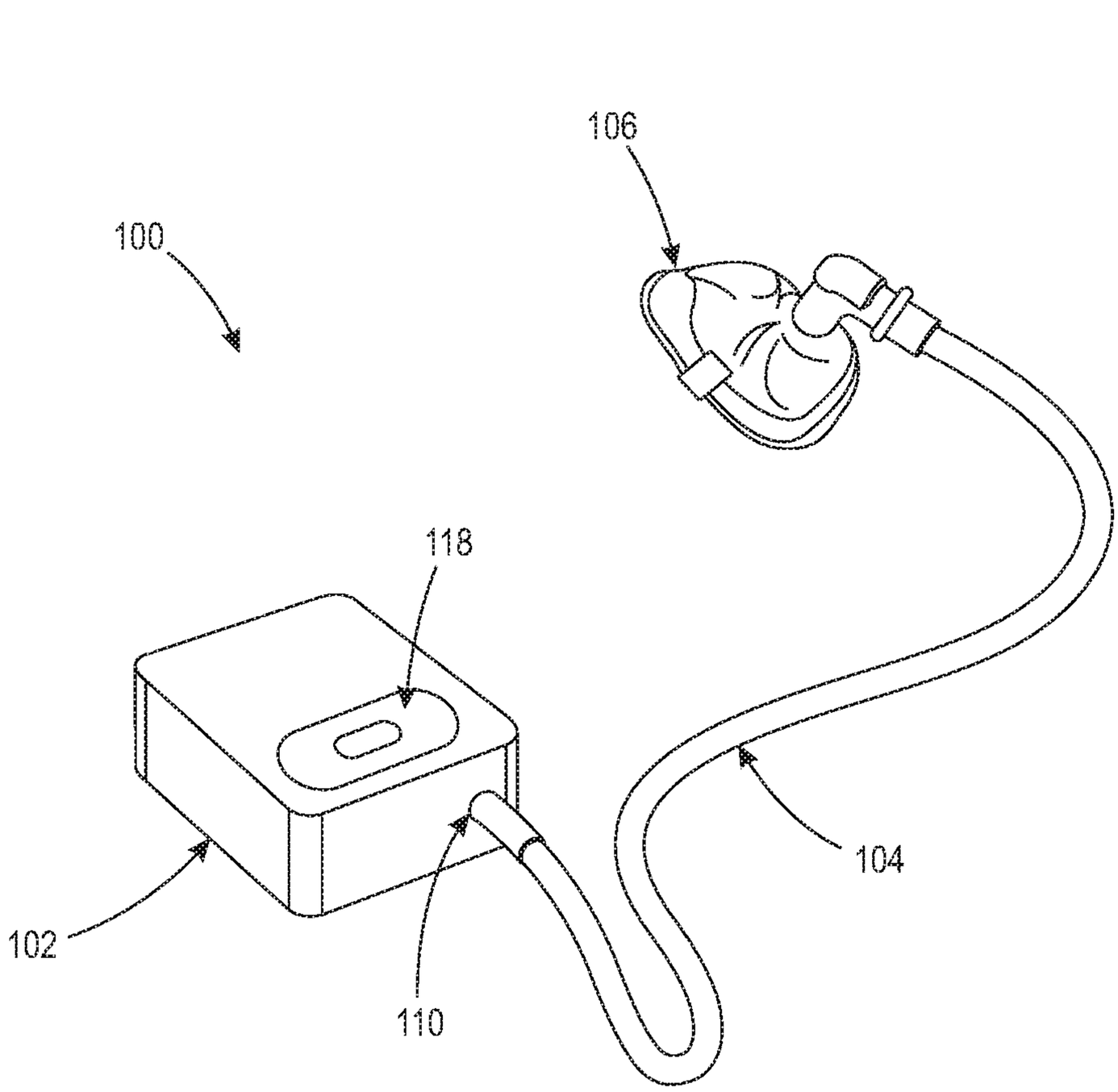


FIG. 1

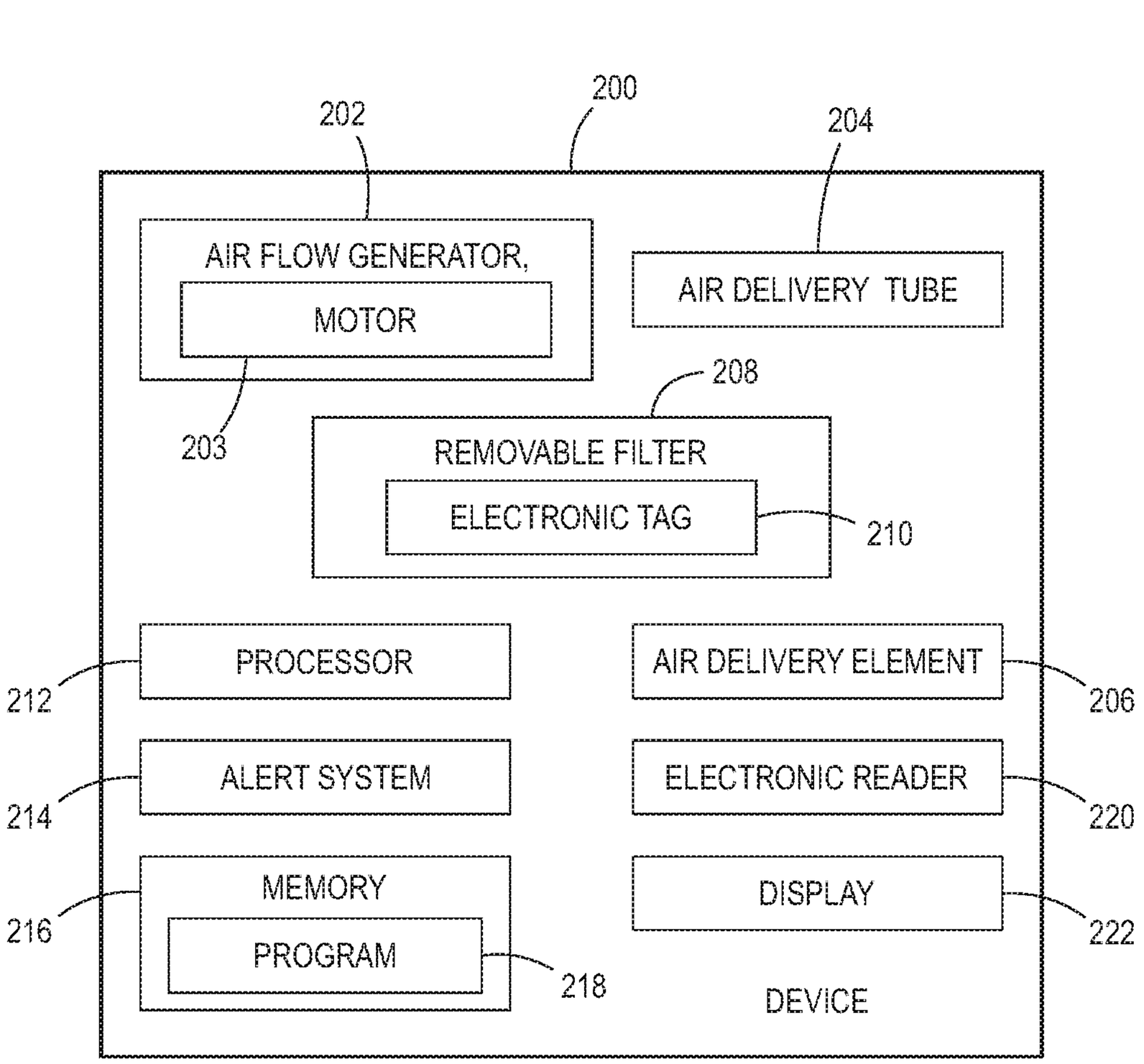

200
202
204
AIR FLOW GENERATOR,
MOTOR
AIR DELIVERY TUBE
203
208
REMOVABLE FILTER
ELECTRONIC TAG
210
PROCESSOR
212
AIR DELIVERY ELEMENT
206
ALERT SYSTEM
214
ELECTRONIC READER
220
MEMORY
216
PROGRAM
218
DISPLAY
222
DEVICE

FIG. 2

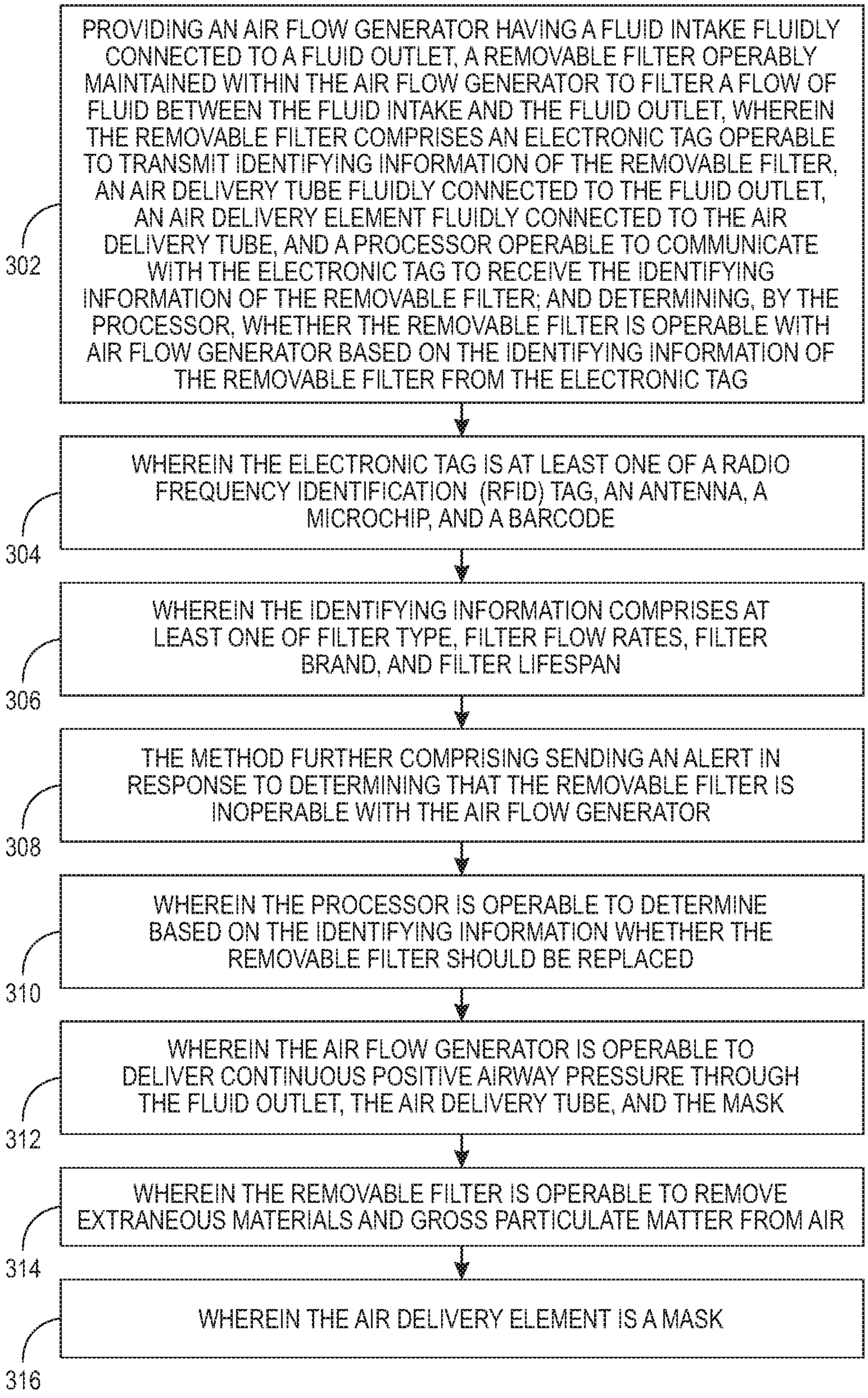

PROVIDING AN AIR FLOW GENERATOR HAVING A FLUID INTAKE FLUIDLY CONNECTED TO A FLUID OUTLET, A REMOVABLE FILTER OPERABLY MAINTAINED WITHIN THE AIR FLOW GENERATOR TO FILTER A FLOW OF FLUID BETWEEN THE FLUID INTAKE AND THE FLUID OUTLET, WHEREIN THE REMOVABLE FILTER COMPRISES AN ELECTRONIC TAG OPERABLE TO TRANSMIT IDENTIFYING INFORMATION OF THE REMOVABLE FILTER, AN AIR DELIVERY TUBE FLUIDLY CONNECTED TO THE FLUID OUTLET, AN AIR DELIVERY ELEMENT FLUIDLY CONNECTED TO THE AIR DELIVERY TUBE, AND A PROCESSOR OPERABLE TO COMMUNICATE WITH THE ELECTRONIC TAG TO RECEIVE THE IDENTIFYING INFORMATION OF THE REMOVABLE FILTER; AND DETERMINING, BY THE PROCESSOR, WHETHER THE REMOVABLE FILTER IS OPERABLE WITH AIR FLOW GENERATOR BASED ON THE IDENTIFYING INFORMATION OF THE REMOVABLE FILTER FROM THE ELECTRONIC TAG
302
WHEREIN THE ELECTRONIC TAG IS AT LEAST ONE OF A RADIO FREQUENCY IDENTIFICATION (RFID) TAG, AN ANTENNA, A MICROCHIP, AND A BARCODE
304
WHEREIN THE IDENTIFYING INFORMATION COMPRISES AT LEAST ONE OF FILTER TYPE, FILTER FLOW RATES, FILTER BRAND, AND FILTER LIFESPAN
306
THE METHOD FURTHER COMPRISING SENDING AN ALERT IN RESPONSE TO DETERMINING THAT THE REMOVABLE FILTER IS INOPERABLE WITH THE AIR FLOW GENERATOR
308
WHEREIN THE PROCESSOR IS OPERABLE TO DETERMINE BASED ON THE IDENTIFYING INFORMATION WHETHER THE REMOVABLE FILTER SHOULD BE REPLACED
310
WHEREIN THE AIR FLOW GENERATOR IS OPERABLE TO DELIVER CONTINUOUS POSITIVE AIRWAY PRESSURE THROUGH THE FLUID OUTLET, THE AIR DELIVERY TUBE, AND THE MASK
312
WHEREIN THE REMOVABLE FILTER IS OPERABLE TO REMOVE EXTRANEOUS MATERIALS AND GROSS PARTICULATE MATTER FROM AIR
314
WHEREIN THE AIR DELIVERY ELEMENT IS A MASK
316

FIG. 3

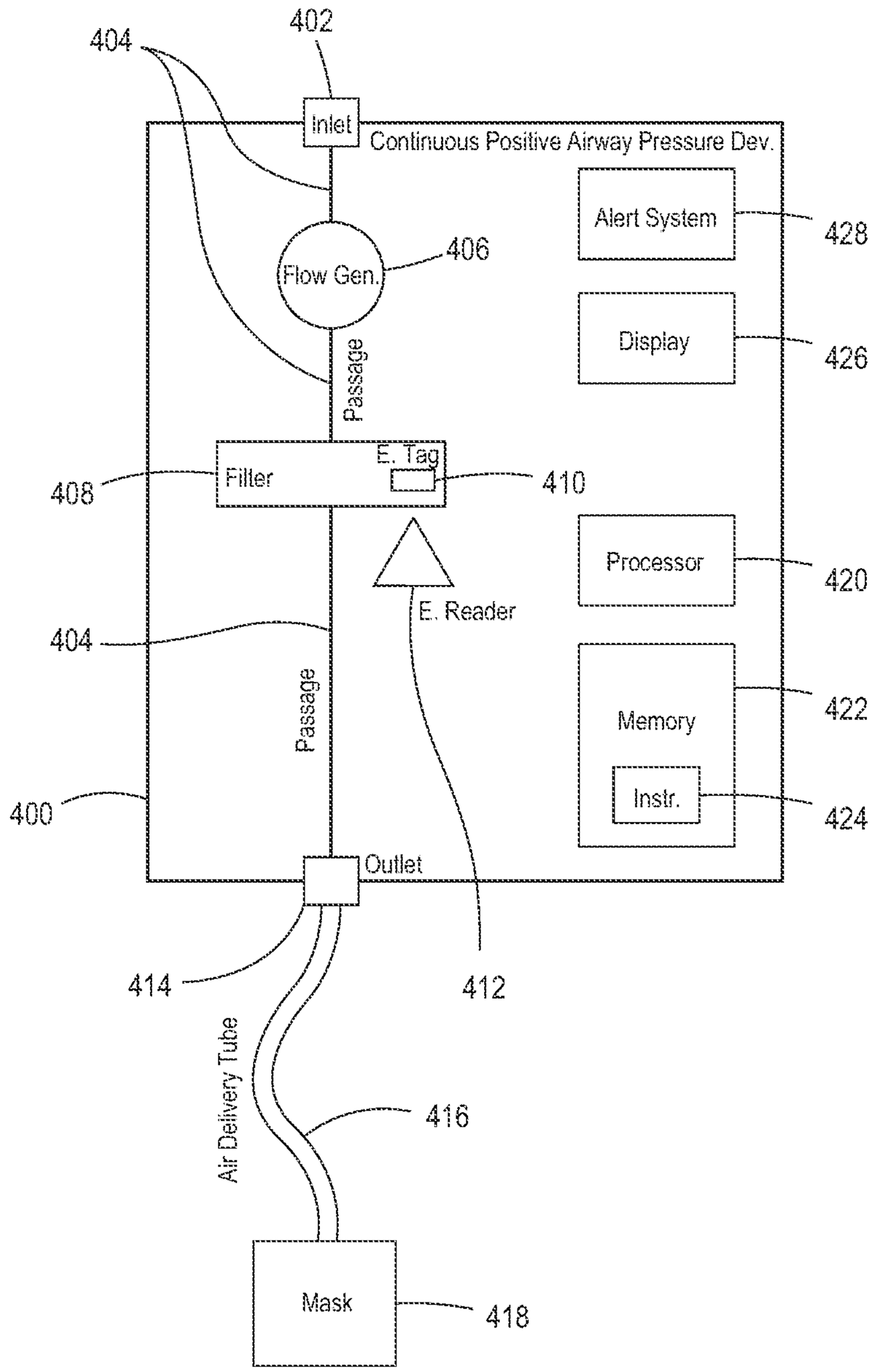

402
404
Inlet
Continuous Positive Airway Pressure Dev.
Alert System
428
406
Flow Gen.
Display
426
Passage
E. Tag
Filter
408
410
Processor
420
E. Reader
404
Memory
422
Passage
Instr.
424
400
Outlet
414
412
Air Delivery Tube
416
Mask
418

FIG. 4

FILTRATION SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

Embodiments of the present disclosure relates to a method and apparatus for filtration. Embodiments of the present disclosure relate more particularly to a method and apparatus for filtration of air and fluids.

Description of Related Art

Continuous positive airway pressure (CPAP) is a type of positive airway pressure ventilation. CPAP applies air pressure on a continuous basis to keep airways open on a continuous basis in a user able to breathe on their own. A CPAP stent the lungs' alveoli open such that they are able to recruit more of the lung's surface area for ventilation. CPAP devices apply continuous positive airway pressure throughout the breathing cycle. A ventilator on a CPAP device does not cycle on and off during use, and no additional pressure above the continuous pressure provided by the CPAP occurs. The user of the CPAP device must initiate each breath during use. CPAP is generally used by people who have sleep apnea or other breathing issues.

BRIEF SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present disclosure to provide an apparatus and method for filtering.

A first exemplary embodiment of the present disclosure provides an apparatus for filtering. The apparatus includes an air flow generator having a fluid intake fluidly connected to a fluid outlet, and a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter comprises an electronic tag operable to transmit identifying information of the removable filter. The apparatus further includes an air delivery tube fluidly connected to the fluid outlet, an air delivery element fluidly connected to the air delivery tube, and a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter.

A second exemplary embodiment of the present disclosure provides a method of filtering. The method includes providing an air flow generator having a fluid intake fluidly connected to a fluid outlet, a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter comprises an electronic tag operable to transmit identifying information of the removable filter, an air delivery tube fluidly connected to the fluid outlet, an air delivery element fluidly connected to the air delivery tube, and a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter. The method further includes determining, by the processor, whether the removable filter is operable with air flow generator based on the identifying information of the removable filter from the electronic tag.

The following will describe embodiments of the present disclosure, but it should be appreciated that the present disclosure is not limited to the described embodiments and various modifications of the disclosure are possible without departing from the basic principle. The scope of the present disclosure is therefore to be determined solely by the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

FIG. **1** presents an exemplary device for filtering suitable for use in practicing exemplary embodiments of this disclosure.

FIG. **2** presents a simplified block diagram of devices suitable for use in practicing exemplary embodiments of this disclosure.

FIG. **3** presents an exemplary logic flow diagram in accordance with a method and apparatus for performing exemplary embodiments of this disclosure.

FIG. **4** presents a schematic of an exemplary device for filtering suitable for use in practicing exemplary embodiments of this disclosure.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present disclosure provide an air flow generator (e.g., a continuous positive airway pressure device) having a fluid intake and a fluid outlet. The air flow generator operable to produce a flow of fluid (e.g., air) from the fluid intake out the fluid outlet to an air delivery tube fluidly connected to the fluid outlet. The air delivery tube is operable to receive the flow of fluid and direct it to an air delivery element (e.g., a mask) at which point the user will be able to receive continuous positive airway pressure from the flow of fluid. The air flow generator is operable to maintain a filter operable to filter the flow of fluid between the fluid intake and the fluid outlet. The filter includes an electronic tag (e.g., a radio frequency identification (RFID), an antenna, a microchip, or a barcode) that is operable to maintain identifying information about the filter. The electronic tag is operable to communicate the identifying information about the filter to a processor. The processor may be maintained within the housing of the air flow generator. The processor is operable to determine (based on the identifying information) whether the filter is the appropriate filter for use with the air flow generator. For example, the processor is operable to determine based on the filter type, filter flow rates, filter brand, and/or filter lifespan whether the filter should be replaced. Accordingly, embodiments of the present disclosure provide a CPAP device with a filter that operably notifies the user whether the filter should be replaced.

Referring to FIG. **1**, shown is an exemplary device for performing exemplary embodiments of the present disclosure. Shown in FIG. **1** is device **100** having an air flow generator **102**, an air delivery tube **104** and a mask **106**. Air flow generator **102** includes a fluid intake **108** and a fluid outlet **110**. Air flow generator **102** is operable to produce a flow of fluid by pulling air or other fluid through the fluid intake **108** and expelling the flow of fluid or air out of the fluid outlet **110**. It should be understood that the flow of fluid may be comprised of liquids, gases, and/or solids. Embodiments of air flow generator **102** include a motor or other similar device operable to produce a flow of fluid.

Air delivery tube **104** is fluidly connected to the fluid outlet **110** to receive the flow of fluid. Air delivery tube **104** is fluidly connected to mask **106** such that air flow generator **102**, air delivery tube **104**, and mask **106** are operable to provide a user with continuous positive airway pressure.

Air flow generator **102** operably maintains at least one filter **112**. Filter **112** is operable to filter extraneous materials, gross particulate matter and other unwanted particles from the flow of fluid flowing between the fluid intake **108**

and the fluid outlet **110**. Some of the extraneous materials can include visible or microscopic particles, organic, or inorganic matter. Filter **112** is removable and replaceable from air flow generator **102**. Embodiments of filter **112** include an electronic tag **114**. Examples of electronic tag **114** include a radio frequency identification (RFID) tag, an antenna, a microchip, and/or a barcode. Electronic tag **114** are operable to maintain identifying information about filter **112**. Examples of identifying information include filter type, filter flow rates, filter brand, and filter lifespan.

Device **100** also includes at least one processor **116**. Processor **116** is operable to communicate with electronic tag **114** and to determine based on the identifying information on the electronic tag **114** whether filter **112** should be replaced. Some embodiments of device **100** also include at least one alert system **118**. The alert system **118** can include any one or combination of signals (e.g., light, vibration, audible sound, etc.) that notifies the user that the filter **112** should be changed. Embodiments of alert system **118** are operably to controlled by or communicate with processor **116** and can send an alert based on whether the processor **116** determines that the filter **112** should be replaced.

Reference is now made to FIG. **2**, which depicts a simplified block diagram of devices suitable for use in practicing exemplary embodiments of this disclosure. Shown in FIG. **2** is device **200** having an air flow generator **202** with a motor **203** for producing a flow of fluid or air. Device **200** also includes an air delivery tube **204** for receiving and transmitting the flow of fluid to air delivery element **206** (e.g., air delivery tube and mask). Device **200** includes a removable filter **208** having an electronic tag **210**, which maintains identifying information about filter **208**.

Device **200** further includes a processor **212** operable to communicate with the electronic tag **210** and to receive the identifying information. Some embodiments of device **200** include an electronic reader **220** operable to obtain the identifying information from electronic tag **210** and communicate the obtained identifying information to processor **212**. In one embodiment electronic reader **220** is an antenna arranged such that it is operable to communicate with electronic tag **210**. Processor **212** is also operable to communicate with alert system **214** for alerting a user to replace or change removable filter **208**. In some embodiments device **200** also includes a memory **216** operable to communicate with processor **212** such that processor **212** can access program **218** stored on memory **216**. Program **218**, when accessed or run on processor **212**, can instruct processor **212** and device **200** to operate or perform operations as described herein.

Processor **212** with memory **216** and program **218** is also operable to calculate and display with display **222** the remaining life of removable filter **208**. Embodiments provide that the established or rated filter life of removable filter **208** can be written on to electronic tag **210**, along with such information as filter type or name, manufacturer, and manufacturing lot number. When a new removable filter **208** is inserted into device **200**, processor (with electronic reader **220**) reads and stores the identifying information in memory **216**. Some examples of information that can be displayed on display **222** include filter life, which may be based on a particular air flow generator **202** speed or intake flow rate which is a function of motor **203** speed.

Referring to FIG. **3**, illustrated is a logic flow diagram in accordance with a method and apparatus for performing exemplary embodiments of this disclosure. Block **302** presents providing an air flow generator having a fluid intake fluidly connected to a fluid outlet, a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter comprises an electronic tag operable to transmit identifying information of the removable filter, an air delivery tube fluidly connected to the fluid outlet, an air delivery element fluidly connected to the air delivery tube, and a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter; and determining, by the processor, whether the removable filter is operable with air flow generator based on the identifying information of the removable filter from the electronic tag. Following block **302**, block **304** specifies wherein the electronic tag is at least one of a radio frequency identification (RFID) tag, an antenna, a microchip, and a barcode.

Some of the non-limiting implementations detailed above are also summarized at FIG. **3** following block **304**. Block **306** presents wherein the identifying information comprises at least one of filter type, filter flow rates, filter brand, and filter lifespan. Then block **308** relates the method further comprising sending an alert in response to determining that the removable filter is inoperable with the air flow generator. Block **310** states wherein the processor is operable to determine based on the identifying information whether the removable filter should be replaced. Next block **312** indicates wherein the air flow generator is operable to deliver continuous positive airway pressure through the fluid outlet, the air delivery tube, and the mask.

Block **314** states wherein the removable filter is operable to remove extraneous materials and gross particulate matter from air. Lastly, block **316** specifies wherein the air delivery element is a mask.

The logic diagram of FIG. **3** may be considered to illustrate the operation of a method, a result of execution of computer program instructions stored in a computer-readable medium, or the operation of an apparatus. The logic diagram of FIG. **3** may also be considered a specific manner in which components of a device are configured to operate, whether such a device is a CPAP device or one or more components thereof.

Referring to FIG. **4**, shown is yet another exemplary continuous positive airway pressure device **400** suitable for performing exemplary embodiments of the present disclosure. Shown in FIG. **4** is device **400** having a fluid inlet **402** that is fluidly connected to air flow generator **406**. Air flow generator **406** is fluidly connected to filter **408**, fluid outlet **414**, air delivery tube **416** and mask **418**. Filter **408** includes an electronic tag **410**, which can be read by electronic reader **412**. Embodiments of filter **408** provide that it can be removed and replaced from device **400** as desired by a user. Embodiments of filter **408** are operable to remove extraneous materials and gross particulate matter from air or fluid passing through passage **404**. Air flow generator **406** is operable to produce a flow of fluid by pulling air or other fluid through fluid inlet **402** and expelling it through filter **408** and out fluid outlet **414**, air delivery tube **416** and mask **418**.

Electronic tag **410** is operable to communicate with processor **420**. Embodiments of electronic tag **410** include a radio frequency identification (RFID) tag, an antenna, a microchip and/or a barcode. Electronic tag **410** is operable to transmit to the electronic reader **412** identifying information regarding filter **408**. Exemplary identifying information include filter type, filter flow rates, filter brand, and filter lifespan. Processor **420** is operable to communicate with and operate memory **422** having computer program instructions **424**, display **426** (which can include a user interface for

operating device **400**), and alert system **428**. Fluid inlet **402**, air flow generator **406**, filter **408** and fluid outlet **414** are fluidly connected through passage **404**, which is operable to allow a flow of fluid through device **400**. Processor **420** is further operable to determine based on the identifying information from electronic tag **410** whether filter **408** is compatible with device **400**. Compatibility can include whether filter **408** is operable to filter out the correct amount of gross particulate matter from fluid that passes through filter **408**. Compatibility can also include size and brand of filter **408**. Processor **420** is also operable to determine based on the identifying information from electronic tag **410** whether filter **408** should be replaced due to the length of time filter **408** has been in use or due to build up on gross particulate matter in filter **408**. Processor **420** is operable to control display **426** and/or alert system **428** to signal and/or display to a user that filter **408** should be replaced, that filter **408** is compatible or incompatible with device **400**, the filter type, filter flow rate, filter brand and filter lifespan of filter **408**. Embodiments of device **400** are operable to deliver continuous positive airway pressure to a user wearing mask **418** through fluid outlet **414**, air delivery tube **416** and mask **418**.

Various embodiments of the computer-readable medium include any data storage technology type which is suitable to the local technical environment, including but not limited to semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory, removable memory, disc memory, flash memory, dynamic random-access memory (DRAM), static random-access memory (SRAM), electronically erasable programmable read-only memory (EEPROM) and the like. Various embodiments of the processor include but are not limited to general purposed computers, special purpose computers, microprocessors, digital signal processors, and multi-core processors.

This disclosure has been described in detail with particular reference to a presently preferred embodiment, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the invention in indicated by the appended claims, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced therein.

The invention claimed is:

1. An apparatus for filtering, the apparatus comprising:

(a) an air flow generator having a fluid intake fluidly connected to a fluid outlet;

(b) a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter comprises an electronic tag operable to transmit identifying information of the removable filter, wherein the identifying information comprises at least a flow rate of the removable filter;

(c) an air delivery tube fluidly connected to the fluid outlet;

(d) an air delivery element fluidly connected to the air delivery tube, wherein the air delivery element is a mask;

(e) a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter, wherein the processor is operable to determine whether the removable filter is compatible with the air flow generator as a function of the flow rate of the removable filter; and

(f) an alert system comprising at least one of a light alarm or an audible alarm, the alert system operable to signal a user that the removable filter is inoperable with the air flow generator.

2. The apparatus according to claim **1**, wherein the electronic tag is at least one of a radio frequency identification (RFID) tag, an antenna, a microchip, and a barcode.

3. The apparatus according to claim **1**, wherein the processor is operable to determine based on the identifying information whether the removable filter should be replaced.

4. The apparatus according to claim **1**, wherein the air flow generator is operable to deliver continuous positive airway pressure through the fluid outlet, the air delivery tube, and the air delivery element.

5. The apparatus according to claim **1**, wherein the removable filter is operable to remove extraneous materials and gross particulate matter from air.

6. The apparatus according to claim **1**, wherein the processor is operable to determine a lifespan of the removable filter as a function of an intake flow rate of the air flow generator.

7. A method of filtering, the method comprising:

(a) providing an air flow generator having a fluid intake fluidly connected to a fluid outlet, a removable filter operably maintained within the air flow generator to filter a flow of fluid between the fluid intake and the fluid outlet, wherein the removable filter comprises an electronic tag operable to transmit identifying information of the removable filter, an air delivery tube fluidly connected to the fluid outlet, an air delivery element fluidly connected to the air delivery tube, and a processor operable to communicate with the electronic tag to receive the identifying information of the removable filter, wherein the air delivery element is a mask, and wherein the identifying information comprises at least a flow rate of the removable filter;

(b) determining, by the processor, whether the removable filter is compatible with the air flow generator based on at least the flow rate of the removable filter; and

(c) sending an alert, by an alert system comprising at least one of a light alarm or an audible alarm, in response to determining that the removable filter is inoperable with the air flow generator.

8. The method according to claim **7**, wherein the electronic tag is at least one of a radio frequency identification (RFID) tag, an antenna, a microchip, and a barcode.

9. The method according to claim **7**, wherein the processor is operable to determine based on the identifying information whether the removable filter should be replaced.

10. The method according to claim **7**, wherein the air flow generator is operable to deliver continuous positive airway pressure through the fluid outlet, the air delivery tube, and the mask.

11. The method according to claim **7**, wherein the removable filter is operable to remove extraneous materials and gross particulate matter from air.

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